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Forest Clear-Cutting Affects Surface Soil Nutrient Cycling

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Harvesting timber from U.S. forests by clear-cutting – removing all the trees in a stand – remains the preferred technique of many privately owned timber companies.

Although clear-cutting on extremely steep slopes or in other sensitive areas (such as bottomlands) has been discouraged by regulations, smaller scale clear-cutting still occurs.

The impact of clear-cutting on ecosystems is now being intensively studied. Sedimentation in local streams, damage to understory plant communities, soil compaction, and significant changes to the soil microbial community have all been associated with clear-cutting.

With support from USDA's National Research Initiative (NRI) Competitive Grants Program, researchers at the University of Tennessee at Chattanooga are investigating the effect of clear-cutting on microbial communities and nutrient cycling supported by those communities.

Permanent study plots are located in Ozark forests of southeastern Missouri. These sites are also part of a long-term ecosystem study by the Missouri Department of Conservation. The Missouri Ozark Forest Ecosystem Project (MOFEP) focus-

A CLEAR-CUT SAMPLE PLOT, SHOWING DEBRIS LEFT ON SITE AND REMAINING TREES, INCLUDING SOME PINES.

MISSOURI DEPARTMENT OF CONSERVATION

Large-scale losses of Mg or K from forested watersheds could endanger the productivity and sustainability of forested ecosystems.

es on various aspects of ecosystem functioning as affected by either clear-cutting or selective harvest of timber. The clear-cuts used in MOFEP are of the smaller scale type, ranging from 1.9 to 35 acres, with an average of 13.7 acres.

A pilot study conducted in Deer Run State Forest near the MOFEP plots indicated that by 2 to 3 years after clear-cut, significant losses of organic sulfur (S) and exchangeable magnesium (Mg) and potassium (K) in A-horizon soils had occurred. Those losses had not been regained by 8 to 10 years post clear-cut.

Prior studies from other forest ecosystems in North America have indicated that ecosystems exhibiting loss of organic sulfur also experience significant losses of soil nutrients, a finding supported in this research. Once nutrients leach out of the soils, they can be lost from the watershed.

Although sulfur loss would rarely be limiting to plants growing in forest surface soils, Mg or K losses could threaten organisms that lack the ability to move to another site or grow deeper roots – such as shallow-rooted plants, microorganisms, or micro-invertebrates (e.g., protozoa). Large-scale losses of Mg or K from forested watersheds could endanger the productivity and sustainability of forested ecosystems.

This project has documented significant losses of total carbon and sulfur, organic sulfur, and exchangeable Mg and K, and reductions in multiple indicators of microbial activity in clear-cut soils, when compared with control site soils.

A common finding in studies of microbial activity in surface soils from clear-cut sites in forests from North America and Europe is a significant reduction in microbial activity 2 to 3 years post-harvest. For the MOFEP soils, it appears that lost exchangeable Mg and K may be responsible for a great deal of the reduced activity of these microbial communities.

In vitro experiments where Mg and K were added back to clear-cut soils to the levels approximating those of control sites resulted in dramatic increases in microbial activity, to levels approximating those of controls. In contrast, additions of nitrate, another nutrient important to plants and microorganisms, usually did not stimulate these microbial populations to become more like control soil populations.

IMPACT

Our society's need for forest products is currently being met through the use of forest management practices that, in some cases, date back to the early 1900s. As we begin to realize the full impact of certain types of clear-cutting on soil processes, the importance of studies that improve our understanding of factors that help maintain soil fertility is clear. ❖

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